

What is Claimed is:

1. An apparatus for fabricating a blank for a microstructure master,
comprising:
a radiation sensitive material coating station that is configured to coat a layer
of radiation sensitive material that is configured to accept an image of
5 microstructures, on a first flexible web; and
a laminating station that is configured to laminate a second flexible web to the
layer of radiation sensitive material that is configured to accept an image of
microstructures, opposite the first flexible web.
- 10 2. An apparatus according to Claim 1 wherein the layer of radiation
sensitive material is a layer of negative photoresist.
3. An apparatus according to Claim 1 wherein the first and second
flexible webs are identical.
- 15 4. An apparatus according to Claim 2 wherein the layer of negative
photoresist is sensitive to radiation at a predetermined frequency and wherein the first
flexible web is transparent to radiation at the predetermined frequency.
- 20 5. An apparatus according to Claim 4 wherein the second flexible web is
opaque to radiation at the predetermined frequency.
6. A method for fabricating a blank for a microstructure master,
comprising:
25 coating a layer of radiation sensitive material that is configured to accept an
image of microstructures, on a first flexible web; and
laminating a second flexible web to the layer of radiation sensitive material
that is configured to accept an image of microstructures, opposite the first flexible
web.
- 30 7. A method according to Claim 6 wherein the layer of radiation sensitive
material is a layer of negative photoresist.

8. A method according to Claim 6 wherein the first and second flexible webs are identical.

5 9. A method according to Claim 7 wherein the layer of negative photoresist is sensitive to radiation at a predetermined frequency and wherein the first flexible web is transparent to radiation at the predetermined frequency.

10 10. A method according to Claim 9 wherein the second flexible web is opaque to radiation at the predetermined frequency.

11. A blank for a microstructure master comprising:
a pair of closely spaced apart, flexible webs; and
a radiation sensitive layer that is configured to accept an image of
microstructures, between the pair of closely spaced apart flexible webs.
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12. A blank according to Claim 11 wherein the radiation sensitive layer contains therein a latent image of microstructures.

20 13. A blank according to Claim 11 wherein the radiation sensitive layer is a negative photoresist layer.

14. A blank according to Claim 13 wherein the pair of flexible webs are identical.

25 15. A blank according to Claim 13 wherein the negative photoresist layer is sensitive to radiation at a predetermined frequency and wherein one of the pair of flexible webs is transparent to radiation at the predetermined frequency.

30 16. A blank according to Claim 15 wherein the other of the pair of flexible webs is opaque to radiation at the predetermined frequency.

17. A method of fabricating microstructures comprising:

imaging a microstructure master blank that comprises a radiation sensitive layer sandwiched between a pair of outer layers, on an imaging platform, to define the microstructures in the radiation sensitive layer; and
removing at least one of the outer layers.

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18. A method according to Claim 17 wherein the pair of outer layers comprise a first outer layer adjacent the imaging platform and a second outer layer remote from the imaging platform and wherein removing comprises removing the second outer layer from the radiation sensitive layer, the method further comprising:

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developing the microstructures that were defined in the radiation sensitive layer; and

creating a second-generation stamper from the microstructures that were developed in the radiation sensitive layer by contacting the microstructures to a stamper blank.

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19. A method according to Claim 18 wherein creating comprises:

creating a second-generation stamper from the microstructures that were developed in the radiation sensitive layer by pressing the microstructures against a stamper blank.

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20. A method according to Claim 18 wherein creating comprises:

creating a second-generation stamper from the microstructures that were developed in the radiation sensitive layer by rolling the microstructures against a stamper blank.

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21. A method according to Claim 18 wherein contacting the microstructures to a stamper blank is performed while the radiation sensitive layer and the first outer layer remain on the imaging platform.

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22. A method according to Claim 17 wherein the pair of outer layers comprise a first outer layer adjacent the imaging platform and a second outer layer remote from the imaging platform, the removing further comprising:

separating the first outer layer from the imaging platform; and

separating the first or second outer layer from the radiation sensitive layer;

wherein the method further comprises:

developing the microstructures that were defined in the radiation sensitive layer; and

creating a second-generation stamper from the microstructures that were
5 developed in the radiation sensitive layer by contacting the microstructures to a stamper blank.

23. A method according to Claim 22 wherein creating comprises:

creating a second-generation stamper from the microstructures that were
10 developed in the radiation sensitive layer by pressing the microstructures against a stamper blank.

24. A method according to Claim 22 wherein creating comprises:

creating a second-generation stamper from the microstructures that were
15 developed in the radiation sensitive layer by rolling microstructures against a stamper blank.

25. A method according to Claim 17 wherein the microstructure master blank is a first microstructure master blank, and wherein removing is followed by:

20 creating a second generation stamper by developing the microstructures in the first microstructure master blank and contacting the microstructures to a stamper blank; and

imaging a second microstructure master blank that comprises a radiation sensitive layer sandwiched between a pair of outer layers, on the imaging platform, to
25 define second microstructures in the radiation sensitive layer;

wherein imaging a second microstructure master blank and creating a second-generation stamper at least partially overlap in time.

26. A method according to Claim 17 wherein imaging is preceded by:

30 placing the radiation sensitive layer sandwiched between a pair of outer layers on the imaging platform.

27. A method according to Claim 17 wherein the imaging platform comprises a cylindrical platform and wherein imaging comprises rotating the

cylindrical platform about an axis thereof while simultaneously rastering a radiation beam through one of the outer layers and across at least a portion of the radiation sensitive layer.

5 28. A method according to Claim 27 further comprising simultaneously translating the cylindrical platform and/or radiation beam axially relative to one another.

 29. A method according to Claim 28 further comprising simultaneously
10 continuously varying amplitude of the radiation beam.

 30. A method according to Claim 17 wherein the radiation sensitive layer is at least about one square foot in area.

15 31. A method according to Claim 17 wherein imaging is performed continuously on the radiation sensitive layer for at least about 1 hour.

 32. A method according to Claim 17 wherein imaging is performed continuously on the radiation sensitive layer for at least about 1 hour to fabricate at
20 least about one million microstructures.

 33. A method according to Claim 17 wherein the microstructures comprise optical and/or mechanical microstructures.

25 34. A method according to Claim 17 further comprising:
developing the microstructures that were defined in the radiation sensitive layer to provide a microstructure master.

 35. A method according to Claim 17 wherein the pair of outer layers are
30 cylindrical, ellipsoidal or polygonal in shape.

 36. A method according to Claim 34 further comprising:
forming a plurality of second generation stampers directly from the master;
and

forming a plurality of third generation microstructure end products directly from a stamper.

37. A method according to Claim 17 wherein the pair of outer layers
5 comprise a first outer layer adjacent the imaging platform and a second outer layer remote from the imaging platform, the imaging comprising:

impinging a radiation beam through the second outer layer into the radiation sensitive layer to define microstructures in the radiation sensitive layer.

10 38. A method according to Claim 17 wherein the radiation sensitive layer is a negative photoresist layer such that portions of the negative photoresist layer that are exposed to the radiation beam remain after development.

15 39. A method according to Claim 17 wherein the pair of outer layers are flexible.

40. A method of fabricating a microstructure master comprising:
placing on a cylindrical platform, a microstructure master blank that comprises
a first outer layer, a negative photoresist layer on the first outer layer and a second
20 outer layer on the negative photoresist layer, such that the first outer layer is adjacent the cylindrical platform and the second outer layer is remote from the cylindrical platform;

impinging a laser beam through the second outer layer into the negative photoresist layer while simultaneously rotating the cylindrical platform about an axis
25 thereof and while simultaneously axially rastering the laser beam across at least a portion of the negative photoresist layer to image the microstructures in the negative photoresist layer;

separating the first outer layer from the cylindrical platform;
separating the first outer layer from the negative photoresist layer; and
30 developing the microstructures that were imaged in the negative photoresist layer.

41. A method according to Claim 40 further comprising:

creating a second-generation stamper from the microstructures that were developed in the negative photoresist layer by contacting the microstructures to a stamper blank.

5 42. A method according to Claim 41 wherein creating comprises:
 creating a second-generation stamper from the microstructures that were developed in the negative photoresist layer by pressing the microstructures against a stamper blank.

10 43. A method according to Claim 41 wherein creating comprises:
 creating a second-generation stamper from the microstructures that were developed in the negative photoresist layer by rolling the microstructures against a stamper blank.

15 44. A method according to Claim 40 wherein the microstructure master blank is a first microstructure master blank and wherein separating the first outer layer from the cylindrical platform is followed by:

 creating a second generation stamper from the microstructures that were developed in the negative photoresist layer of the first microstructure master blank by
20 contacting the microstructures to a stamper blank;

 placing on the cylindrical platform, a second microstructure master blank that comprises a first outer layer, a negative photoresist layer on the first outer layer and a second outer layer on the negative photoresist layer, such that the first outer layer is adjacent the cylindrical platform and the second outer layer is remote from the
25 cylindrical platform;

 impinging the laser beam through the second outer layer of the second microstructure master blank into the negative photoresist layer of the second microstructure master blank while simultaneously rotating the cylindrical platform about an axis thereof and while simultaneously axially rastering the laser beam across
30 at least a portion of the negative photoresist layer of the second microstructure master blank to image the microstructures in the negative photoresist layer of the second microstructure master blank;

wherein creating a second generation stamper and impinging the laser beam through the second outer layer of the second microstructure master blank at least partially overlap in time.

5 45. A method according to Claim 40 further comprising simultaneously translating the cylindrical platform and/or laser beam axially relative to one another.

 46. A method according to Claim 45 further comprising simultaneously continuously varying amplitude of the laser beam.

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 47. A method according to Claim 40 wherein the microstructure master blank is at least about one square foot in area.

 48. A method according to Claim 47 wherein impinging is performed
15 continuously on the microstructure master blank for at least about 1 hour.

 49. A method according to Claim 48 wherein impinging is performed continuously on the microstructure master blank for at least about 1 hour to fabricate at least about one million microstructures.

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 50. A method according to Claim 40 wherein the microstructures comprise optical and/or mechanical microstructures.

 51. A method according to Claim 42 further comprising:
25 forming a plurality of third generation microstructure end products directly from a stamper.

 52. A method according to Claim 40 wherein the first and second outer layers are flexible.

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